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SECURITY INFORMATION

PROVISIONAL INTELLIGENCE REPORT

PETROLEUM IN THE SOVIET BLOC

SYNTHETIC OIL INDUSTRY IN THE USSR

CIA/RR PR-17 (L-E)

18 June 1952

Note

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FOREWORD

This report is one of a series of provisional reports pertaining to petroleum in the Soviet Bloc. The entire series is intended to cover all phases of petroleum, natural gas, and synthetic liquid fuels in the Soviet Bloc. These reports are presented as an intermediate step in consolidating pertinent intelligence on the subject and not as a finished study. In the consolidation of the available information, various reports and documents representing research by other intelligence agencies were utilized along with the results of research and analysis by members of the staff of CIA.

It is intended that this series of reports will serve the following purposes:

a. Represent a base for contributions and additions by CIA and other agencies actively interested in petroleum intelligence.

b. Facilitate the selection of the specific and detailed gaps in intelligence warranting priority attention.

c. Provide the basis for a broad study on petroleum in the Soviet Bloc and various studies directed toward specific critical problems.

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Approved For Release 2002/05/09 : CIA-RDP79-01093A000200010013-2

TABLE 2

Preliminary Estimate of Production of Coal Carbonization Chemicals

	Thousand Metric Tons per Year	
Chemical from Coal Carbonization	USSR 1951	US 1949
Crude Benzene	270.0	a/
Refined Benzene	200.0	470.0 b/
Toluene	48.7	226.0 b/
Xylene	17.5	172.0 b/
Coal Tar	1,060.0	
Naphthalene	44.3	135.0
Phenol	9.3	101.0 c/
Cresols	14.8	5.6
Xylenols	2.7	
Anthracene	70.2	
Creosote Oil	281.0	
Pitch	458.0	
Solvent Naphtha	20.1	
Pyridine	8.3	
Ammonium Sulfate	292.0	
NH_3 in Ammonia Liquor	8.3	

a/ Cf. preceding table for USBM estimates of the same yields.

b/ Including the stocks separately obtained in petroleum processing.

c/ Including synthetic phenol production.

1. Survey of the True Synthetic Oil Industry in the USSR

a. Basic Technology.

The synthetic liquid fuel industry in the USSR is in a process of rapid expansion with concentrated effort being given to the areas devoid of natural petroleum resources but rich in lignite and bituminous coal deposits. The present study deals with the status of the Bergius hydrogenation and the Fischer-Tropsch synthesis processes.

The Bergius process is a destructive hydrogenation method of producing hydrocarbon oils from higher molecular weight organic substances; it is a conversion accomplished in the presence of suitable catalysts by heating the charge with hydrogen under high pressure (300 to 700 atmospheres). The attendant chemical reactions are complex. In the case of coal which contains substantial quantities of combined oxygen, nitrogen, and sulfur, the first effect is to remove most of these elements in a combined form, leaving what are substantially high boiling hydrocarbons. Under the influence of heat these hydrocarbons split or crack into lower molecular weight substances (usually hydrocarbons) some of which are necessarily unsaturated or deficient in hydrogen. The essential feature of this destructive hydrogenation process is that in the presence of hydrogen and a suitable catalyst at high pressure, the primary products of the cracking reaction are partially saturated with hydrogen as soon as formed, thereby minimizing the polymerization reactions which yield heavier products with the ultimate formation of solid carbon or coke, and which are characteristic of the ordinary thermal cracking processes. Satisfactory hydrogenation therefore depends on the choice of

of temperature, hydrogen pressure, reaction time, and especially the catalyst which will ensure a proper balance between the cracking and hydrogen absorption reactions. A characteristic of the process is that by suitable choice of conditions, including the extent of recycle of intermediate products for further breakdown, it can be halted at any desired stage so as to produce a variety of oil products. Coal may be hydrogenated for example to give heavy fuel oil with a comparatively small amount of gasoline and hydrocarbon gas, or conditions can be chosen so that the final product consists entirely of high volatility aviation gasoline and hydrocarbon gases 2/.

In actual operation of the Bergius process using bituminous coal or lignite (brown coal) as the feed stock, the final oil product is produced in two stages:

(1) Treatment in the liquid phase, usually with a dispersed powder catalyst (about 0.1% tin oxalate + 1% ammonium chloride for bituminous coal), resulting in the yield of a product consisting mainly of middle oil (390° to 615° F boiling range).

(2) Vapor phase hydrogenation of this middle oil to gasoline over an active fixed catalyst (usually tungsten sulfide types).

Yields of total liquid products from hydrogenation of run of mine coal, based on recent pilot plant data in the United States, are as follows 3/:

(a) 2.0 bbls/ton when using a good grade of bituminous coal as feed
(b) 1.5 bbls/ton when using a sub-bituminous coal as feed
(c) 1.0 bbls/ton when using lignite as feed

Gasoline recovery represents 50 to 60% by weight of the above yields. The motor gasoline yield approaches the higher figure (60%) while aviation gasoline would be nearer the lower one.

The Fischer-Tropsch process comprises the synthesis of liquid and solid aliphatic hydrocarbons with these formed from mixtures of carbon monoxide and hydrogen. The process can be subdivided into the following major steps: preparation of the gas mixture, synthesis in two or more stages in the presence of iron or cobalt catalyst, condensation and collection of the primary products, and separation and processing of the latter to yield marketable products. By using cobalt catalyst in this synthesis at 7 atmospheres pressure, major products in the German process were wax, oil, water, gaseous hydrocarbons and a little CO_2. The hydrocarbons were largely straight-chain paraffins. However, a more recent application of fluidized catalyst techniques (using iron catalyst) has resulted in a process producing about 70% motor gasoline with about 30% of fuel oil and oxygenated compounds 4/.

b. Production Estimates and Future Development.

It is known that several of the most important synthetic liquid fuel plants in Eastern Germany were dismantled by the Russians in 1945 and 1946 and sent to the USSR for installation. The Bergius hydrogenation plants reportedly dismantled consisted of Blechhammer, Pölitz, Magdeburg, Auschwitz, and part of Leuna. The Fischer-Tropsch plants removed were Schwarzheide and Deschowitz 5/6/7/8/9/10/11/12/. The total capacity of these dismantled installations amounted to about 1,600,000 tons of liquid oil products per year. It is reported that the Blechhammer and Pölitz plants were transported to the Lake Baikal area as part of the new "Krasnoye" project, which is scheduled to produce 400,000 tons of aviation gasoline per year when completed. (Table 3,h). Another report places the dismantled Auschwitz plant at Kemerovo in the Kuznetsk

coal basin. (Table 3, f). Further data on the known and doubtful synthetic plants are shown in Table 3 and Table 4* with production estimates also shown for 1951 and for the first year of a war during fiscal 1953. Totals of 650,000 metric tons for 1951 and 1,325,000 metric tons for fiscal 1953 are given for the synthetic oil production in the USSR.

A composite estimate [redacted] 25X1 25X1 [redacted] in the United States revealed that about 35% of the dismantled Bergius equipment would be usable at a new site in the USSR provided that it was shipped very carefully and completely protected at its destination. Approximately 15% of dismantled equipment from a Fischer-Tropsch plant could be utilized at a new site. An opinion expressed by these experts also indicated that the construction time for new synthetic plants in the USSR would be perhaps 4 to 6 years, or 50% longer than that required by experienced personnel in the German industry. This reasoning was not based on the lack of research or professional capabilities, but upon the lack of trained technical operating crews in the USSR. However, [redacted] 25X1 25X1 [redacted] the Soviets have sufficient skill for the full-scale development of synthetic fuels, and with the aid of German technologists and equipment, are as far advanced as anyone in synthetic fuel potentials. Soviet research personnel are watching foreign developments very closely and utilize them in their own practices to check results and advance their learning. Only about 10% of the technical work done in the USSR is published and the complete story is never told in the publication, leaving an impression of lack of knowledge 13/ 14/.

* For Table 4, see Annex, Appendix A.

TABLE 3

Known Synthetic Liquid Fuel Plants in the USSR *

Plant	Location: Eco Reg	Location: Coal Basin	Type & Quantity of Coal Available	Process Used	**Est. Capacity at completion	**Est. 1951 Production	**Est. War Time Prod (Fisc '53)
					Thousand Metric Tons per Year		
a/ Stalino	3	Donetz	Good quality bit.	Bergius Hydrogenation	300	100	150
b/ Irmino	3	Donetz	" " "	"	200	50	100
c/ Lisichansk	3	Donetz	" " "	"	200	-	50
d/ Tkvibuli	5	Georgian	Good quality bit. and lignite	"	200	-	100
e/ Leninsk-Kuznetsky	9	Kuznetsk	Good quality bituminous	"	300	100	200
f/ Kemerovo	9	Kuznetsk	Good quality bituminous	"	50	-	25
g/ Chernogorsk	11	Minusinsk	"	"	400	100	200
h/ "Krasnoye Project" (Cheremkhovo)	11	Irkutsk	Fair quality bituminous	"	1000	300	500
TOTAL					2750	650	1325

* Sources are listed in the Annex, Appendix A.
** Expressed as quantity of total liquid fuels.

It is probable that with increased emphasis on the synthetic fuel program the trained persons available as graduates of technical schools will increase markedly and provide an adequate source of supervisory and operating personnel. Although shortages probably will exist, especially in high pressure vessels, special steel alloys, repair facilities, etc., an all-out effort certainly will be made to remedy the shortages so that the growth of the synthetic fuel industry in the USSR will proceed with a minimum of interruption.

The Soviets obviously have access to all the most recent developments in the Bergius and Fischer-Tropsch processes since the non-Communist agencies undertaking research in this field have divulged the results of their efforts to the general public, with this information released in an attempt to distribute a widespread knowledge for possible mutual benefit. It is quite logical to assume that the Soviets will take advantage of this information to perfect their own processes of synthetic fuel production. It seems apparent that they will also devote considerable attention to the expansion of synthetic liquid fuel production by processing coal and lignite in petroleum deficient areas. This reasoning is based on the probability that continued growth of the USSR natural petroleum industry will be offset in the future due to increasing depletion rates in crude production, with severe strain also exerted on existing transportation facilities to move the petroleum stocks into the remote petroleum-deficient areas, especially East Siberia. Therefore it is anticipated that synthetic liquid fuels will play an ever increasing role in the USSR.

2. Survey of the Oil Shale Industry in the USSR.

The USSR oil shale industry is concentrated primarily in the Estonian SSR. The Estonian oil shale or "kukersite" deposits exist along the southern shores of the Gulf of Finland between the 26th and 28th meridians, and these deposits also have an eastward extension along the Narva River into the Leningrad area (Gdov). Undeveloped Soviet oil shale deposits have been reported in the Saratov area on the lower Volga, in the Kashpir area on the middle Volga, and in the Nizhne Gorod district of Western Siberia. Some oil shale mining operations have been indicated at Kashpirovka in Kuibyshev Oblast. The Estonian oil shale is reportedly the richest in oil content in the world with the amount of oil varying between 17 and 30 percent by weight. This is far superior to the oil shale quality in other European countries where development of the oil shale industry has occurred. Liquid products from Estonian shale were of such high quality that they were exported to other European countries prior to World War I. 15 / 16/.

In the Estonian SSR both underground mining and surface quarrying are employed to extract the oil shale, with the former method accounting for 90% of the production. Prior to 1939 most of the oil shale mining in Estonia was manual, but after the German and Soviet occupations the mines have become highly mechanized and the labor force has been greatly increased to attain greater production. The oil is extracted from the raw shale by means of various types of fired retorts. The present Soviet extraction apparatus includes the Pintsch vertical retort, the Davidson rotary retort, and the usual types of tunnel kilns 17/18/.

The general process employed in all of these types of retorts involves gasification of the volatiles in the crushed shale charge with the heat furnished by combustion gas directed from a fired bed of shale and released countercurrent to the cold incoming shale, thus producing shale oil vapors, product gas, and spent shale. The vapors are condensed by the cold incoming shale and the resulting crude oil and water mixture is settled and separated. The oil is caustic washed before being sent to storage. Most of the modern retorting procedures have the advantage of eliminating the use of water for the cooling of spent shale and for the condensing of shale oil.

The Estonian shale oil is then refined via the normal processes of atmospheric distillation and thermal cracking, reportedly yielding a motor gasoline with an octane number of 65 to 70 and a Diesel oil suitable for farm tractors. Phenol-type impregnating oils and asphalt are also produced from this refining step. Reports do not refer to the possible production of kerosene and other burning oils. Recent pilot plant experience in the US indicates, however, that visbreaking, hydrogenation, hydroforming, and catalytic cracking can also be integrated in the refining process to produce high grade gasoline, premium Diesel fuel, and good jet fuel 19/. Another innovation with possible application is the rapid high temperature (1200°F to 1800°F) retorting of oil shale to form a highly aromatic oil which should be valuable in preparing high octane blending stocks 20/.

After World War II every effort was made by the Soviets to rehabilitate the Estonian oil shale industry. Separate Oil Shale Ministries were formed with top priority for achieving this rehabilitation. Reports indicate that the increases in mechanization and labor force were instituted after 1946 to achieve the Five-Year Plan goal of 900,000 metric tons of liquid products to be obtained in 1950 from shale and coal.

25X1 Estimates made [redacted] revealed that approximately 1,000,000 metric tons of crude oil from shale alone were actually anticipated for 1950. However,

25X1 [redacted] this goal would not be achieved for at least two years after the scheduled date 21/.

Shale oil retorting and refining plants in Estonia were damaged during World War II by both the Germans and Soviets. The Soviets started reconstruction in 1946 on the existing plants at Khotla Jarve, Kivioli, and Sillamae, with production resumed in these by 1948. Kivioli was also enlarged and a new plant was built at Ahtme. There are recent reports of a plant to be completed at Slantsy (?) in 1951 22/ 23/ 24/. A former small plant at Tursamae is also reported to be under reconstruction and it may possibly be in production after 1951 (Table 6, Item 5).* Recent information further disclosed another large plant to have been under construction in 1944 at Jokhvi; this plant was damaged and the present status is unknown (Table 6, Item 8).*

Based upon the published data in the US Bureau of Mines reports plus data from other sources, the oil shale, crude shale oil, and shale oil gasoline productions in

* For Table 6, see the [illegible], Appendix A.

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Estonia are revealed through 1939. A recovery of 11% of crude oil from the total mined oil shale was the maximum obtained up to that time despite the reported 17 to 30% of oil content in the shale. This low figure was obviously due to the face that much of the shale was used for fuel in refinery operations as well as for certain domestic and other uses. With increased efficiency in the post-war period a factor of at least 14% is presently assumed for the net crude oil extraction from USSR oil shale.

The breakdown of crude oil production from oil shale is shown in the attached Table 5,* with 700,000 metric tons indicated for 1951 and 1,000,000 metric tons for the first year of a war in fiscal 1953. Other shale oil plants which may be under construction or planned for the near future are shown in Table 6.*

It is quite probable that an increased expansion of the oil shale industry in the USSR will occur in the future since an estimated 4 to 5 billion tons reserve of rich oil shale exists in the Estonian territory in addition to about 20 billion tons in other widely distributed areas of the USSR. The crude shale oil available from these oil shale sources is estimated at approximately 4 billion tons. This compares with the one billion tons of proved reserves and the 22 to 27 billion tons of probable reserves estimated for natural petroleum in the USSR. With recent US developments available to the Soviets it appears that they might readily utilize these improvements in their shale oil refining methods to provide hydrocarbon liquid fuels of good quality and help meet the increased civil and military requirements. It is quite logical to assume that the development of the Soviet oil shale industry will proceed with vigor in order to supplement natural petroleum.

* For Table 5 and 6, see the annex, appendix.

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